Vol. 9, No. 5 September-October, 1947

THE OSCILLOGRAPHER

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THE DU MONT TYPE 275-A CATHODE-RAY POLAR-COORDINATE INDICATOR

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Designed for studying all types of rotating machinery and for plotting phenomena on a circular time base, the Du Mont Type 275-A Cathode-ray Polar-coordinate Indicator provides a new tool for the design and maintenance of industrial equipment.

The use of a circular time base for the presentation of data has certain distinct advantages, such as:

1. Continuous time base (no time lost on retraces).
2. A given spot position on the time base always corresponds to the same space phase, or rotation angle, regardless of speed.
3. Presentation on a circular (or angular) time base corresponds to methods customarily used in the study of rotating machinery.

A standard cathode-ray tube (Du Mont Type 5CP-A), is used as the indicator. An external two-phase generator is furnished with the Type 275-A Indicator to provide two sine-wave signals of equal amplitude and 90° phase difference; these signals produce the circular time base. This generator is usually coupled to the shaft of the apparatus from which the signal is obtained. Hence, in the Type 275-A Cathode-ray Polar-coordinate Indicator, the signal under examination is always synchronized with the circular sweep on the cathode-ray tube, since the sweep is controlled directly by the speed of the rotating machine.

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Radial deflection is obtained by modulation of these two 90° out-of-phase sine-wave signals which produce the circle. These signals are applied to the control grids of pentodes in the push-pull (balanced) deflection amplifier. By applying the modulating signal to the screen grids of these tubes, their transconductances are varied according to the instantaneous signal amplitude.

The frequency response of the radial amplifier is essentially flat from less than 2 cps to 30 kc. Less than 0.4 volt (rms) is required to provide deflection to the center of the circle. The circle

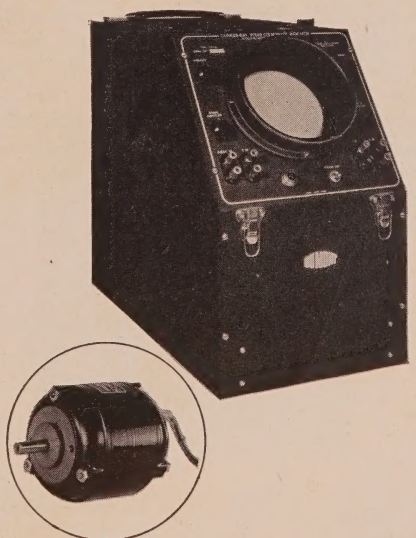

FIGURE 1—Du Mont Type 275-A Cathode-ray Polar-coordinate Indicator and External Circular Time-Base Generator.

diameter is constant from 1/2 to 60 cycles per second and is essentially free of phase shift from 5 to 60 cycles per second.

The Type 275-A Polar-coordinate Indicator is designed for use in the laboratory or in the field. For convenience in viewing the screen from various positions, the tube is set at an angle of 55° with respect to the vertical and a retractable light shield is provided.

The intensity and focus controls are mounted on the panel with the radial-amplitude and circle-amplitude controls, the pilot light, the power switch, and the input terminals for the radial and X-, Y-, and Z-axis signals. A cover protects these controls during transportation. Other controls are grouped behind a door in the top of the instrument. These include AN-type connectors in parallel with the front-panel terminals for the circle (X and Y) and radial signals, and a power-input connector.

Applications

In conjunction with other equipment, the Type 275-A Cathode-ray Polar-coordinate Indicator has been employed in the test, analysis, and adjustment of automobile and aircraft engines. Timing, chatter, and valve adjustment for each cylinder may be displayed with respect to crankshaft angle. Vibration may be located, detonation (knock) studied, fuels of different octane ratings distinguished, and carburetor adjustment facilitated with the Type 275-A.*

Since the two-phase generator is driven by the crankshaft, the circular oscillogram remains stationary, automatically locked in synchronism; each cylinder is displayed in rotation approximately equally spaced around the circle.

The application of the Du Mont Type 275-A to the analysis of the operation of the ignition system of a six-cylinder automobile engine has been accomplished in the laboratory by using the circuit shown in Figure 2. This laboratory set-up duplicates the ignition system and permits a study of interrupter adjustment and operation and also a check on spark plug firing and electrode spacing. An electric motor was used to drive the interrupter, distributor and the two-phase time base generator. For operation in an automobile, this generator may be coupled to the accessory shaft, either directly or through an auxiliary tachometer shaft.

The performance of the interrupter may be determined from a study of Figure 3. These oscillograms show a pulse of voltage generated each time that the contacts were opened by the cam. In general, the oscillogram is not a simple square-pulse pattern because

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* Refer to the paper presented at the annual meeting (January, 1947) of the Society of Automotive Engineers: "The Development of Detonation Instrumentation for Automotive Vehicles," by J. H. Goffe and J. W. Wheeler of Sperry Gyroscope Company, Inc.

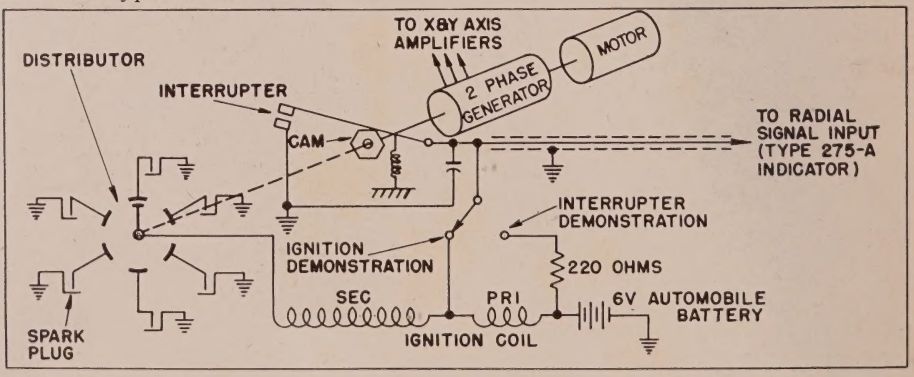

FIGURE 2—Circuit Diagram for Study of the Adjustment and Performance of the Ignition System of a Six-cylinder Automobile Engine.

of the inductance of the coil and the capacitance across the interrupter.

The correct setting of the contacts can be accurately determined with the Du Mont Type 275-A because the effect of each adjustment can be observed on the indicator.

A B C

FIGURE 3—Oscillograms Showing Distributor Adjustment on a Six-cylinder Automotive Engine: (A) Correctly adjusted; (B) Slightly out of adjustment, note contact bounce; (C) Incorrect adjustment. pronounced bouncing.

The performance of the ignition system may be observed if the demonstrator switch is at the position shown in Figure 2; in this setting the radial signal input terminals are connected across the primary winding of the ignition coil.

Figure 4 is a composite oscillogram containing six separate traces, one for each spark plug in the ignition system of a six-cylinder automobile engine. Each trace is an oscillogram of the shock oscillation voltage across the primary winding of the ignition coil during the interval that the high secondary voltage is applied to a particular spark plug. These individual traces may be interpreted to determine whether a plug is firing, the length of the firing period, and from this information it is possible to predict the electrode spacing and condition of the corresponding plug.

The trace for the first plug in Figure 4 represents the case of the plug that fails to fire because the electrodes are spaced too far apart to permit breakdown.

Inspection of the oscillograms for plugs 2, 3, 5, and 6 reveals that the amplitudes of the traces suddenly diminish; this decrease in voltage is due to the loading of the coil and is evidence that these plugs are firing normally.

Because the spark plug and the gap in the distributor are in series, the applied voltage is across the distributor when a plug is shorted. The shorted plug may be identified by an oscillogram such as that shown for plug 4; the indicated breakdown period shown is longer than that for a plug that is firing normally. This occurs because a voltage below the minimum required for the maintenace of the spark between the two gaps in series is sufficient to sustain a spark across the distributor alone. Thus defective spark plugs may be quickly located using this technique, which is more direct than the usual cut-and-try methods.

Similarly, this method may be applied to the timing and adjustment of any type of rotating machine. In the case of textile machinery, shuttle motion with regard to heddle position may be easily observed with the aid of the Type 275-A Indicator, and adjustments are possible without the presence of material in the machine. This technique requires less time than present methods and obviates threading and rethreading the looms due to a breakage of thread by the shuttle.

The type 275-A Polar-coordinate Indicator may be employed in vibration and pressure-time studies when used in conjunction with vibration and pressure pick-ups which are commercially available.

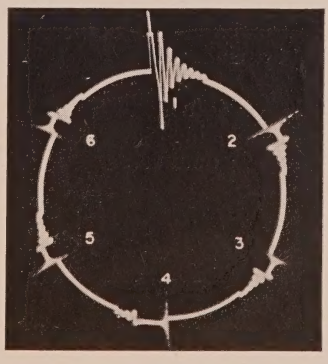

FIGURE 4—Composite Oscillogram Showing Six Separate Traces of the Voltage Across the Primary Winding of the Coil in Figure 2. Each trace corresponds to a spark plug; plugs 2, 3, 5, and 6 are firing normally, plug 1 is open, and plug 4 is shorted.

Specifications

Cathode-ray Tube
- Type 5CP-A
- Screen Diameter ..... 5 inches
- Accelerating Potential (over-all) ..... 3000 volts

Radial Signal Amplifier
- Input Resistance—250,000 ohms (for 1:1 attenuation)
  —2.45 megohms (for 10:1 attenuation)
- Deflection Factor—Approximately 0.1 v (rms) per inch of deflection.
  —Less than 0.4 v (rms) required for deflection to center of circle.
- Polarity of Deflection—Positive signal increases instantaneous circle diameter.
- Maximum Input Potential—600 volts (d-c + peak signal).
- Frequency Response—No more than 10% variation in output voltage from 2 cps to 30 kc.
- Input Selection—1. External signal with 1:1 attenuation.
  2. External signal with 10:1 attenuation.
  3. Sine-wave test signal (line frequency).

Circle (X and Y) Amplifiers
- Input—from two-phase generator.
- Frequency Response—No perceptible changes in amplitude from 1/2 to 60 cps.
  —No perceptible change in phase from 5 to 60 cps.
- Useful Circle Diameter—Up to 4½ inches.
- Polarity of Deflection—Positive signal deflects outward from the center of the circle.
- Orientation—Shaft of the generator marked for top of circle, switch provided to remove X signal for orientation.

Intensity Modulation (Z-axis)
- Input—Capacitively coupled to cathode-ray tube grid.
- Input Resistance—2.2 megohms.
- Sensitivity—45 volts (±50%) peak positive signal will drive cathode-ray tube from cut-off to zero bias.

Power Input
- Voltage—115/230 v ±10%.
- Frequency—50-60 cps.
- Power Consumption—100 watts.
- Fuse Protection—1.5 amperes.

Physical Specifications
- Height—17 inches.
- Depth—19½ inches.
- Width—10½ inches.
- Weight—65 pounds.
- Finish—black wrinkle.
- Panel—55°-angle sloping panel with removable cover.

Accessories Supplied:
- 1 Two-phase generator with ten-foot leads and connector.
- 1 Du Mont Type 216-F Calibrated Scale (transparent), calibrated from 0 to 360° counterclockwise with 0° at right.

Catalog No.	Type No.	Description	Code Word
1250-E	*275-A*	*Cathode-ray Polar-Coordinate Indicator with Type 5CP1-A cathode-ray tube, 115 V, 50-60 cycles.*	*YALBZ*
1251-E	*275-A*	*Same as 1250-E except with Type 5CP2-A cathode-ray tube*	*YALCA*
1253-E	*275-A*	*Same as 1250-E except with Type 5CP7-A cathode-ray tube*	*YALCC*
1254-E	*275-A*	*Same as 1250-E except with Type 5CP11-A cathode-ray tube*	*YALCD*
1255-E	*275-A*	*Cathode-ray Polar Coordinate Indicator with Type 5CP1-A cathode-ray tube, 230 V, 50-60 cycles.*	*YALCE*
1256-E	*275-A*	*Same as 1255-E except with Type 5CP2-A cathode-ray tube*	*YALCF*
1258-E	*275-A*	*Same as 1255-E except with Type 5CP7-A cathode-ray tube*	*YALCH*
1259-E	*275-A*	*Same as 1255-E except with Type 5CP11-A cathode-ray tube*	*YALCJ*